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PESTICIDE USE ON FALL POTATOES
IN THE UNITED STATES, 1979

by

John R. Parks

January 1983

ERS Staff Report No. AGES830113

Natural Resource Economics Division
Economic Research Service
U.S. Department of Agriculture
Washington, D.C. 20250

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ABSTRACT

Growers treated more fall potatoes with insecticides than any other pesticide. Just over 1.0 million acres were included in the survey and 94 percent were treated with an insecticide. Potato farmers made 6.8 million acre-treatments, using 15.3 million pounds active ingredient of pesticides. Applying pesticides in single application was the most common practice. Tank-mix applications were used in 6 percent of the time. Each region used about the same amount of pesticides not considering nematicides. Nematicide use was largely in the Western region. More insecticides were used in the Western region and more fungicides were used in the Northeast and North Central regions. However relative relationships varied with the number of acres planted by region. Treatments with pesticides ranged on the average from 1.0 to 4.9 times per season and were as high as 7.5 times in treating diseases in the Northeast. Coefficients of variation were calculated for acres treated with specific pesticides.

Key words: Pesticides, potatoes (fall), herbicides, fungicides, insecticides, vine killers, growth regulators, *Solanum tuberosum L.*

ACKNOWLEDGMENTS

Many growers, enumerators, data processors, and others have contributed to this report. Larry Roberson, Survey Division, Statistical Reporting Service, USDA, is acknowledged for coordinating survey efforts with the States. The author is particularly indebted to Hugh Murphy, University of Maine at Orono, Duane Preston, University of Minnesota at East Grand Forks, and Walter C. Sparks, formerly University of Idaho at Aberdeen, for their biological, ecological, and physiological insights that helped us to understand relationships reflected in the survey data. A number of knowledgable people, in each State surveyed, have reviewed the regional reports and were acknowledged in them. Kenneth M. Koester, Jr., Data Service Center, Economic Research Service, USDA, has been most helpful, timely, and cooperative in data management. Thanks to Andrea Lunsford for preparing drafts and formatting.

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PESTICIDE USE ON FALL POTATOES IN THE UNITED STATES 1979

INTRODUCTION

In 1979 the U.S. Department of Agriculture completed a survey of pesticide use on fall potatoes. The potato, Solanum tuberosum L., is important from an economic point of view. The value of U.S. potato production in 1979 was estimated at $1.2 billion. Potatoes were planted on 1.3 million acres and commercial production was reported in 39 States. Fall potatoes made up 1.1 million of the 1.3 million acres planted to potatoes (Table 1). Just over 1.0 million acres of fall potatoes were planted in the 11 States that were surveyed--Colorado, Idaho, Maine, Michigan, Minnesota, New York, North Dakota, Oregon, Pennsylvania, Washington, and Wisconsin (Figure 1).

Pesticides are important in potato production for controlling weeds, diseases insects, and nematodes that reduce yields and lower quality. From a cost standpoint, pesticides are an important consideration because pesticide costs average about 20 percent of total variable costs (1, 2).

This report presents information about: (a) the proportion of planted acres treated by pesticide category, (b) the total acre-treatments, (c) the quantities of pesticides used by active ingredient (a.i.), and (d) the number of times an acre was treated.

The data will be useful in evaluating pesticide use patterns and the economic impact of pesticide regulatory action on farmers and consumers. Among those who will find this report useful are State pesticide agencies, Agricultural Experiment Stations, Cooperative Extension Services, researchers in private institutions, industry fieldmen, farmers, policymakers, and the general public. For those interested in pesticide use on a regional basis reports are available for the Western, North Central, and Northeast potato producing regions.

METHODS

The survey was taken by the State Statistical Offices who completed 1,585 questionnaires by personal interview (Table 2). The sample was selected from just over 1.0 million acres of fall potatoes planted in 11 States in 1979. Statisticians designed a two-stage multiframe sample. The sample fields were selected from a list of known growers (list frame). Area tracts (area frame) also were used to insure that all growers in the known potato producing areas had an opportunity to be included in the sample. Sample fields were randomly selected; the probability of being selected was proportional to field size. Three regions were established:

Western -- Colorado, Idaho, Oregon, and Washington.

North Central -- Michigan, Minnesota, North Dakota, and Wisconsin.

Northeast -- Maine, New York, and Pennsylvania.

RELIABILITY OF ESTIMATES

Estimates based on surveys have varying degrees of statistical reliability. Confidence in data depends on sample size, sampling methods, and the variability of responses. To provide some indication of the reliability of the estimates, coefficients of variation (CV's) are presented in Appendix Tables 1 and 2. The CV is a measure of the relative variation (expressed in percentage terms), and can be used to indicate the degree of confidence a user can place in the estimate. The smaller the CV, the more reliable the estimate.

In simplest terms, it can be said there is a 95 percent confidence that the sample represents the true population and that the true value for the population lies within an interval defined as $\pm$ 2 CV's times the estimated value. For example, with a CV of 10 percent and an estimate of 40, the interval would be 32 to 48. However, there is also a 5 percent chance that the true value

States included in a survey of pesticide use on fall potatoes, United States, 1979.

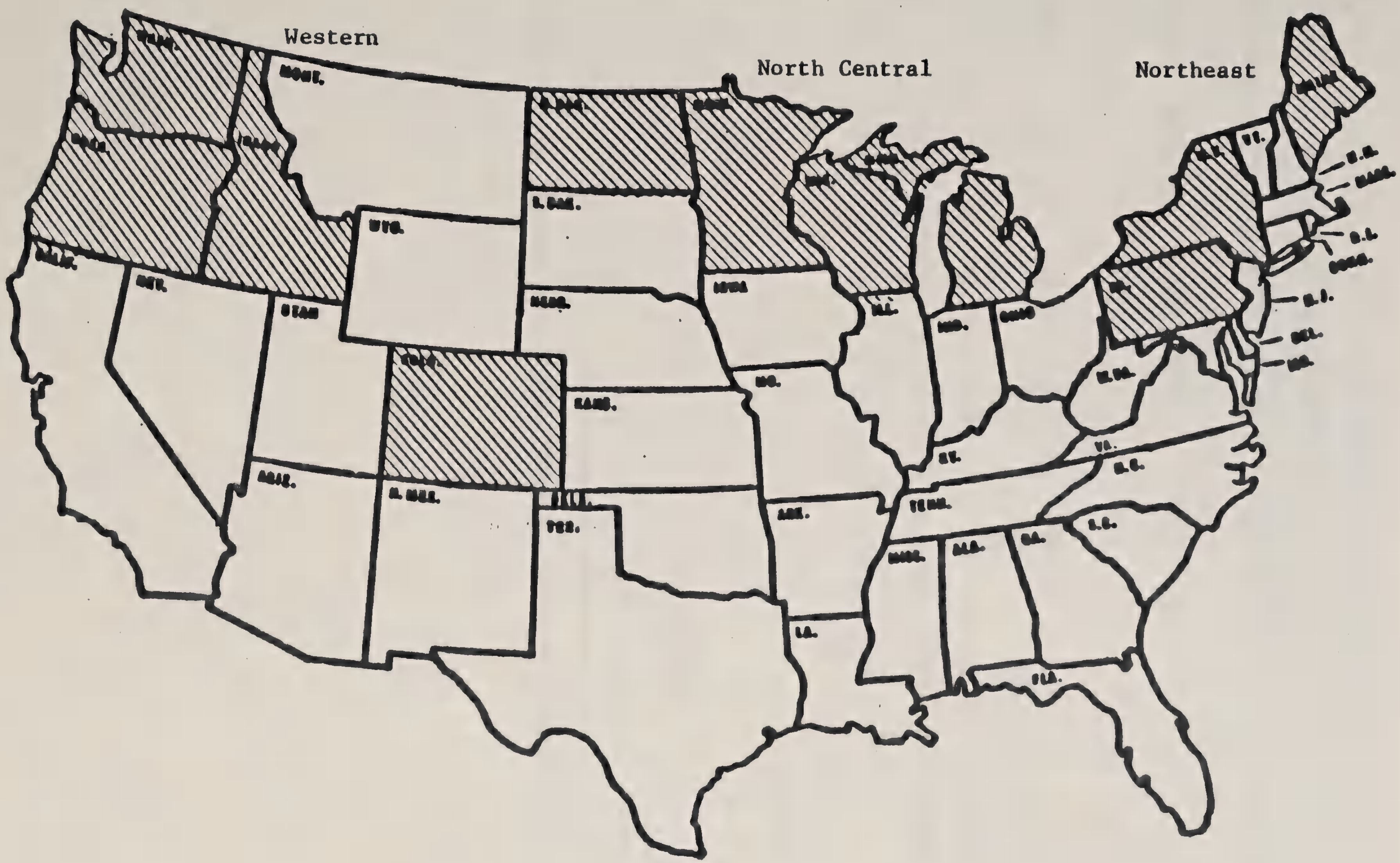

Figure 1

Table 1. Potato production characteristics, 1979 a/

Season and region	Acres: Planted	Acres: Harvested	Harvested acre cwt: Production	Harvested acre cwt: Yield	Price per cwt	Value of production
	1,000	1,000	Million	Million	Dollars	Million dollars
Fall (Surveyed)						
Western	543	535	170	319	2.81	479
North Central	281	268	56	210	3.69	207
Northeast	188	182	47	256	3.72	174
Total	1,012	985	273	277	3.15	860
(Unsurveyed)	89	86	24	277	4.24	102
Total	1,101	1,071	297	277	3.24	962
Winter/Spring/Summer (Unsurveyed)	215	205	46	277	4.61	212
U.S. TOTAL, All Seasons	1,316	1,276	343	269	3.43	1,174

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

Table 2. Sample characteristics for national survey, 1979 a/

Region	Growers sampled	Questionnaires completed	Completion rate
	No.	No.	Percent
Western	850	664	78
North Central	760	528	69
Northeast	490	393	80
Total	2,100	1,585	75

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

does not fall within the interval as defined above because the sample is not representative of the population.

CV's were calculated only for acres treated with specific pesticides. The estimates of acres treated are expected to have greater variation than other data reported. Consequently, for most other information included in this report, the level of reliability should be equal to or greater than reported for acres treated.

DEFINITIONS

For a clearer understanding of the data, a number of terms are defined as follows:

Active ingredient - Pesticide quantities are expressed in terms of active ingredients (a.i.). This is the chemical substance in a formulation that controls the pest. Inert ingredients such as talc, clay, or solvents used as carriers are not included in the quantity estimates.

Times applied - The number of times a land area was treated with a specific pesticide.

Treated acres - The land area treated with a specific pesticide one or more times. Acres treated with different pesticides cannot be summed because a given land area may have been treated with more than one pesticide.

Acre-treatment - The acres treated with a specific pesticide times the number of applications. Since acre-treatments account for both the area and number of applications, acre-treatments with different pesticides can be summed without double counting.

Tank-mix - Two or more pesticides mixed in the spray tank and applied in a single application.

RESULTS OF SURVEY

General Pesticide Use

In the national survey of 11 States, more potato acreage was treated with insecticides than any other category of pesticide, 94 percent (Table 3).

Herbicides and fungicides were the second and third most commonly used pesticides. The percent of planted acres treated with herbicides ranged from 48 percent in the North Central region to 96 percent in the Northeast. The percent of planted acres treated with fungicides was highest in the Northeast. Fewer acres were treated with vine killers, nematicides, and growth regulators than the other categories of pesticides surveyed.

Potato growers in the United States made almost 7 million acre-treatments using 15.3 million pounds (a.i.) of pesticides. The average application rate was 2.3 pounds (a.i.) per acre-treatment. Pesticides were largely made in single applications, 94 percent. Tank-mixes were not commonly used (Table 4).

The survey examined how often growers applied pesticides. It was found that fungicides were applied more often than any other category, ranging from 1.4 to 4.9 times per season (Table 4). Insecticides were applied 1 to 3 times per season. The remaining categories of pesticides were generally applied 1 time per season.

More acre-treatments were made to control diseases, 42 percent of all acre-treatments, than for any other pest problem reported in the survey (Table 4). Insect pests were close to second. Just over 2.0 million, or 30 percent of all acre-treatments were made to control insects. Less than 1 percent of all acre-treatments were made to control nematodes. In localized areas nematodes are an important pest problem.

The following sections present use patterns and suggest biological, ecological, and physiological reasons for the relationships in the survey data.

Table 3. Fall potato acreage and proportion of planted acres treated with pesticides in the United States, 1979 a/

Region	Acres planted	Proportion treated with Herbicides	Fungicides	Insecticides	Nematicides	Vine killers	Growth regulators
	1,000	Percent					
Western	543	78	45	93	8	29	3
North Central	281	48	81	96	8	55	10
Northeast	188	96	97	96	14	81	4
Total	1,012	73	64	94	9	46	5

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

Table 4. Summary of pesticides used on fall potatoes in the United States, 1979 a/

Pesticides	Acre-treatments		Quantity applied (a.i.) Total		Per acre-treatment	Times applied
	1,000	Percent	1,000 lbs.	Percent	---- Lbs. -----	No.
Single applications						
Herbicides	845	13	1,080	7	1.3	1.0-1.1
Fungicides	2,833	42	3,586	23	1.3	1.4-4.9
Insecticides	1,983	29	3,031	20	1.5	1.0-3.0
Nematicides	54	<1	5,343	35	98.9	1.0
Vine killers	557	8	1,150	8	2.1	1.0-1.2
Growth regulators	54	<1	166	1	3.1	1.0
Tank-mixes	403	6	910	6	2.3	1.0-3.0
Total	6,729	100	15,266	100	2.3	-

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

Herbicides

Proportionately more potato acreage was treated with herbicides in the Northeast than in any other region. Northeast growers treated 96 percent of their potato acreage with a herbicide (Table 3). Herbicides ranked third in the number of acre-treatments growers made in the surveyed States. Over 1.0 million pounds (a.i.) were used at an average rate of 1.3 pounds (a.i.) per acre-treatment.

In general, herbicide use patterns vary by regions. Similar herbicides are used in each region but the quantity applied and extent of use varied. The Western region applied the largest quantity of herbicides, just over 500,000 pounds (a.i.). This would be expected since over 54 percent of the surveyed fall potato acreage was in the Western region. The application rate there is the lowest of any region, 1.0 pound (a.i.) per acre-treatment. The rate ranged from 1.0 pound in the Western region to 1.7 pounds in the North Central region. The number of applications in the 11 States was in a narrow range of 1.0 to 1.1 times per season (Table 5).

Over half of all acre-treatments of herbicides are made in the Western region, and over half of the planted acres are there also. In contrast the Northeast region had 24 percent of the herbicide acre-treatments (Table 5), but has less than 20 percent of the acres planted to potatoes (Table 1).

More acres of potatoes were reported treated with metribuzin (41 percent of the surveyed planted acres) than any other herbicide. The share of the metribuzin treated acres as a percent of planted acres varies from 53 percent in the Western, 37 percent in the Northeast, and 19 percent in the North Central region.

Metribuzin requires moisture shortly after treatment to be effective. The large share of the fall potatoes treated with metribuzin in the Western region

Table 5. Herbicide use on fall potatoes in the United States, 1979 a/

Region and herbicide	Treated acres b/	Acre-treatments	Quantity applied (a.i.) Total	Per acre Treated	Per acre Treatment	Times applied
	1,000	1,000	1,000 lbs.	Lbs.	Lbs.	No.
Western						
Alachlor	4.4	4.4	11.3	2.6	2.6	1.0
Dinoseb	8.7	9.9	23.6	2.7	2.4	1.1
Diphenamid	8.9	8.9	15.0	1.7	1.7	1.0
EPTC	78.2	83.4	239.7	3.1	2.9	1.1
Metribuzin	288.3	312.7	169.3	.6	.5	1.1
Trifluralin	65.0	68.7	38.8	.6	.6	1.1
Other	-	2.1	2.9	-	1.8	-
Total	-	490.1	500.6	-	1.0	-
North Central						
Alachlor	11.9	12.7	26.3	2.2	2.1	1.1
Chlorobromuron	1.6	1.6	3.1	1.9	1.9	1.0
Dalapon	4.3	4.3	24.0	5.6	5.6	1.0
EPTC	39.7	40.6	136.4	3.4	3.4	1.0
Linuron	26.7	26.7	24.2	.9	.9	1.0
Metribuzin	52.3	58.8	32.0	.6	.5	1.1
Other	-	4.5	7.2	-	1.6	-
Total	-	149.2	253.2	-	1.7	-
Northeast						
Chlorobromuron	1.8	2.2	3.7	2.1	1.7	1.2
Dalapon	6.3	6.3	36.3	5.8	5.8	1.0
Dinoseb	43.4	44.7	95.2	2.2	2.1	1.0
EPTC	20.3	20.6	101.1	5.0	4.9	1.0
Linuron	47.9	47.9	39.4	.8	.8	1.0
Metribuzin	70.2	79.9	45.0	.6	.6	1.1
Other	-	4.1	5.1	-	1.2	-
Total	-	205.7	325.8	-	1.6	-
3 Regions						
Alachlor	16.3	17.1	37.6	2.3	2.2	1.1
Chlorobromuron	3.4	3.8	6.8	2.0	1.8	1.1
Dalapon	10.6	10.6	60.3	5.7	5.7	1.0
Dinoseb	52.1	54.6	118.8	2.3	2.2	1.0
Diphenamid	8.9	8.9	15.0	1.7	1.7	1.0
EPTC	138.2	144.6	477.2	3.5	3.3	1.1
Linuron	74.7	74.6	63.6	.9	.9	1.0
Metribuzin	410.8	451.4	246.3	.6	.6	1.1
Trifluralin	65.0	68.7	38.8	.6	.6	1.1
Other	-	10.7	15.2	-	1.4	-
Total	-	845.0	1,079.6	-	1.3	-

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materals may have been used on the same acre resulting in multiple counting.

is because most of the potatoes are irrigated, and metribuzin is more easily managed under irrigation. Metribuzin is a selective pre- and postemergent herbicide that controls such weeds as velvetleaf, ragweed, pigweed, and cocklebur (6). Metribuzin is a relatively new herbicide. As a postemergent spray application, metribuzin's effectiveness is readily observed, a factor in its being widely adopted.

The second most commonly used herbicide was EPTC, accounting for 17 percent of all acre-treatments in the nation. Metribuzin and EPTC account for just over 70 percent of all herbicide acre-treatment and 67 percent of the total pounds (a.i.) of all herbicides used of fall potatoes in 1979.

EPTC is a selective preplant herbicide applied prior to weed germination, and controls weeds such as nutsedge, Johnsongrass, and quackgrass (6). EPTC must be incorporated into the soil because it is readily lost by volatization if the soil surface is wet. It is more often used and is most effective where rainfall is low during the growing season and irrigation is not practiced.

Fungicides

Nationally, growers treated 64 percent of the fall potato acreage with a fungicide. The proportion of the potato acres treated with fungicides varied by region: Northeast, 97 percent; North Central, 81 percent; and Western, 45 percent (Table 3). More acre-treatments were made with fungicides than any other category of pesticides, 2.8 million or 42 percent. Growers used 3.6 million pounds (a.i.) to control diseases on potatoes. The rate of use was 1.3 pounds (a.i.) per treatment (Table 4).

In general, fungicide use patterns vary by region. Similar fungicides are used in each region but their extent of use and the quantity applied varied.

The most intensive use of fungicides was in the Northeast region where almost 1.7 million pounds (a.i.) or 47 percent of the United States total was

used (Table 6). This is noteworthy as the Northeast contains only 20 percent of the planted acres (Table 1). The rate per acre-treatment is comparable with other regions but the number of times applied is the highest ranging from 2.5 to 7.5 for specific fungicides. In contrast the Western region made about 15 percent of all fungicide acre-treatments but planted over 50 percent of the potato acreage.

More acres of potatoes were treated with maneb/mancozeb nationally (37 percent of the planted acres) and regionally than any other fungicide reported (Tables 1 and 6). The proportion of maneb/mancozeb treated as a percent of the planted acres varied from 71 percent in the Northeast, 46 percent in the North Central, and 20 percent in the Western region. Maneb/mancozeb is used to control early and late blight. It is used in the Northeast primarily to control late blight which is more of a problem than early blight.

The second most commonly used fungicide was chlorothanlonil (Table 6). Of the acres planted to fall potatoes in 1979, 11 percent were treated with chlorothanlonil to control early or late blight. It was used in all three of the producing regions. Maneb/mancozeb and chlorothanlonil account for just over 78 percent of all acre-treatments.

Maneb/mancozeb has been in use a long time and is more dependable than other fungicides (4). It controls a wider range of diseases than any other fungicide and is compatible in tank-mixes with a number of insecticides and other fungicides. Maneb/mancozeb is applied to the foliage and its frequency of use is influenced by environmental conditions (7).

Chlorothalonil is a broad spectrum, preventative, foliar fungicide. It is registered for control of early and late blight on potatoes (7 and 3). However, it does not have the range of disease control as maneb/mancozeb.

Table 6. Fungicide use on fall potatoes in the United States, 1979 a/

Region and fungicide	Treated acres b/	Acre-treatments	Quantity applied (a.i.) Total	Per acre Treated	Per acre Treatment	Times applied
	1,000	1,000	1,000 lbs.	Lbs.	Lbs.	No.
Western						
Anilazine	7.1	9.7	7.4	1.0	.8	1.4
Captafol	39.4	56.8	67.2	1.7	1.2	1.4
Chlorothalonil	57.4	77.6	66.6	1.2	.9	1.4
Fentin hydroxide	17.1	21.0	4.7	.3	.2	1.2
Maneb/mancozeb	109.3	206.9	265.1	2.4	1.3	1.9
Metiram	5.6	8.5	12.1	2.2	1.4	1.5
Sulfur	33.8	59.7	330.1	9.8	5.5	1.8
Other	-	2.6	1.1	-	.4	-
Total	-	442.8	754.3	-	1.7	-
North Central						
Captafol	6.9	27.7	37.2	5.4	1.3	4.0
Chlorothalonil	27.1	148.9	127.9	4.7	.9	5.5
Copper	21.5	52.4	48.5	2.3	.9	2.4
Fentin hydroxide	47.1	137.5	25.8	.5	.2	2.9
Maneb/mancozeb	128.8	612.2	825.8	6.4	1.3	4.8
Metiram	10.2	53.5	74.2	7.3	1.4	5.2
Total	-	1,032.2	1,139.4	-	1.1	-
Northeast						
Captafol	26.0	91.4	82.5	3.2	.9	3.5
Chlorothalonil	29.0	172.3	145.7	5.0	.8	5.9
Copper	2.7	6.8	8.9	3.3	1.3	2.5
Maneb/mancozeb	134.0	1,000.9	1,335.6	10.0	1.3	7.5
Metiram	14.1	85.5	119.7	8.5	1.4	6.1
Other	-	1.0	.1	-	.1	-
Total	-	1,357.9	1,692.5	-	1.2	-
3 Regions						
Anilazine	7.1	9.7	7.4	1.1	.8	1.4
Captafol	72.3	175.9	186.9	2.6	1.1	2.5
Chlorothalonil	113.5	398.8	340.2	3.0	.9	3.5
Copper	24.2	59.2	57.4	2.4	1.0	2.5
Fentin hydroxide	64.2	158.5	30.5	.5	.2	2.5
Maneb/mancozeb	372.1	1,820.0	2,426.5	6.5	1.3	4.9
Metiram	29.9	147.5	206.0	6.9	1.4	4.9
Sulfur	33.8	59.7	330.1	9.8	5.0	1.8
Other	-	3.6	1.2	-	.3	-
Total	-	2,832.9	3,586.2	-	1.3	-

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materals may have been used on the same acre resulting in multiple counting.

Insecticides

More potato acreage was treated in all regions with an insecticide than any other pesticide, accounting for 94 percent of the planted acres (Table 3). Growers made almost 2.0 million acre-treatments of insecticides, 30 percent of all pesticide treatments. They used about 3.0 million pounds (a.i.) of materials to control insects on potatoes, resulting in a national average use rate of 1.5 pounds (a.i.) per acre-treatment (Table 7).

In general, insecticide use patterns varied by region. Similar insecticides were used in each region but their rate and extent of use varied considerably. The Western region applied the largest quantity of insecticides, about 1.8 million pounds (a.i.), or 58 percent of all insecticides applied. Its use rate is the highest at 2.1 pounds (a.i.) per acre-treatment (Table 7). Insecticides were applied 1.0 to 3.0 times per season, yet nearly 40 percent of the insecticide acre-treatments were applied one time during the season.

Western region potato growers made 850,000, acre-treatments with insecticides, 40 percent of the total while Northeast growers made 550,000 or 27 percent. Of the 20 insecticides reported by growers, 4 accounted for 50 percent of the insecticide acre-treatments (Table 7). Those materials are aldicarb, disulfoton, methamidophos, and phorate. They represent almost 70 percent of the total quantity applied. Methamidophos was used to make more acre-treatments than any of the other 19 insecticides presented.

Aldicarb is used in the Western region to control aphids, mites, and early generations of the Colorado potato beetle with about 31 percent of the planted acres treated. The Colorado potato beetle is a severe problem on Long Island and higher application rates of aldicarb were used in 1979 under a special local and need registration.

Disulfoton was used to treat 228,000 of fall potatoes acres (Table 7). It

Table 7. Insecticide use on fall potatoes in the United States, 1979 a/

Region and insecticide	Treated acres b/	Acre-treatments	Quantity applied (a.i.) Total	Per acre Treated	Per acre Treatment	Times applied
	1,000	1,000	1,000 lbs.	Lbs.	Lbs.	No.
Western						
Aldicarb	170.4	171.6	474.7	2.8	2.8	1.0
Azinphosmethyl	17.8	23.8	11.2	.6	.5	1.3
Disulfoton	158.8	164.2	449.9	2.8	2.7	1.0
Endosulfan	44.1	56.2	38.0	.9	.7	1.3
Fonofos	66.4	66.8	169.7	2.6	2.5	1.0
Malathion	12.6	12.6	17.9	1.4	1.4	1.0
Methamidophos	142.8	215.5	202.0	1.4	.9	1.5
Parathion	5.8	8.1	5.7	1.0	.7	1.4
Phorate	101.3	113.7	282.5	2.8	2.5	1.1
Sulfur	9.5	11.6	104.2	11.0	9.0	1.2
Other	-	6.0	16.8	-	1.0	-
Total	-	850.1	1,772.6	-	2.1	-
North Central						
Aldicarb	53.9	54.9	141.7	2.6	2.6	1.0
Azinphosmethyl	61.7	102.6	57.8	.9	.6	1.7
Carbaryl	38.5	84.8	85.0	2.2	1.0	2.2
Carbofuran	6.3	7.0	13.1	2.1	1.9	1.1
Dimethoate	12.1	31.6	12.8	1.1	.4	2.6
Disulfoton	28.6	28.6	60.7	2.1	2.1	1.0
Endosulfan	20.6	45.5	32.1	1.6	.7	2.2
Methamidophos	46.6	76.9	66.6	1.4	.9	1.7
Methomyl	7.4	11.2	9.9	1.3	.9	1.5
Monocrotophos	16.8	24.9	24.8	1.5	1.0	1.5
Parathion	16.2	41.0	19.0	1.2	.5	2.5
Phorate	51.9	52.8	115.3	2.2	2.2	1.0
Phosphamidon	17.0	31.9	19.4	1.1	.6	1.9
Other	-	12.9	11.3	-	.9	-
Total	-	606.6	669.5	-	1.1	-
Northeast						
Aldicarb	59.7	61.6	188.4	3.2	3.1	1.0
Azinphosmethyl	13.5	22.5	12.0	.9	.5	1.7
Carbaryl	16.4	29.1	24.7	1.5	.8	1.8
Carbofuran	21.2	68.6	69.3	3.3	1.0	3.2
Demeton	23.0	35.2	13.0	.6	.4	1.5
Disulfoton	40.7	42.2	88.5	2.2	2.1	1.0
Endosulfan	28.6	98.8	78.8	2.8	.8	3.5
Fenvalerate	11.1	24.0	4.1	.4	.2	2.2
Methamidophos	25.1	40.9	38.0	1.5	.9	1.6

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Table 7. Insecticide use on fall potatoes in the United States, 1979 a/ -- continued

Region and insecticide	Treated acres b/	Acre-treatments	Quantity applied (a.i.): Total	Per acre: Treated	Per acre: Treatment	Times applied
	1,000	1,000	1,000 lbs.	Lbs.	Lbs.	No.
Northeast (cont'd)						
Parathion	25.3	55.2	49.0	1.9	.9	2.2
Permethrin	10.4	31.3	5.3	.5	.2	3.0
Phorate	3.8	4.2	10.2	2.7	2.4	1.1
Other	-	12.4	8.0	-	.6	-
Total	-	526.0	589.3	-	1.1	-
3 Regions						
Aldicarb	284.0	288.1	804.8	2.8	2.8	1.0
Azinphosmethyl	93.0	148.9	81.0	.9	.5	1.6
Carbaryl	54.9	113.9	109.7	2.0	1.0	2.1
Carbofuran	27.5	75.6	82.4	3.0	1.1	2.8
Demeton	23.0	35.2	13.0	.6	.4	1.5
Dimethoate	12.1	31.6	12.8	1.1	.4	2.6
Disulfoton	228.1	235.0	599.1	2.6	2.6	1.0
Endosulfan	9.3	200.5	148.9	1.6	.7	2.2
Fenvalerate	11.1	24.0	4.1	.4	.2	2.2
Fonofos	66.4	66.8	169.7	2.6	2.5	1.0
Malathion	12.6	12.6	17.9	1.4	1.4	1.0
Methamidophos	214.5	333.3	306.6	1.4	.9	1.5
Methomyl	7.4	11.2	9.9	1.3	.9	1.5
Monocrotophos	16.8	24.9	24.8	1.5	1.0	1.5
Parathion	47.3	104.3	73.7	1.6	.7	2.2
Permethrin	10.4	31.3	5.3	.5	.2	3.0
Phorate	157.0	170.7	408.0	2.6	2.4	1.1
Phosphamidon	17.0	31.9	19.4	1.1	.6	1.9
Sulfur	9.5	11.6	104.2	11.0	9.0	1.2
Other	-	31.3	36.1	-	1.2	-
Total	-	1,982.7	3,031.4	-	1.5	-

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materals may have been used on the same acre resulting in multiple counting.

is used to control insects that transmit virus diseases to potatoes. Certified seed potatoes must be free of disease. Methamidophos is used to control second generations of insects as they build up during the longer growing season of the West. Growers in Idaho, for example, may follow disulfoton applications with a treatment of methamidophos. Methamidophos controls potato leafhopper, potato fleabeetle, potato aphid, as well as the green peach aphid that spreads leaf roll virus.

Aldicarb, disulfoton, methamidophos, and phorate are all systemic insecticides and with the exception of aldicarb, come in several different formulations (5). Aldicarb is available only in granular form and is the only insecticide used on potatoes that is also registered for control of nematodes. Aldicarb's use as a nematicide was relatively minor and in this report it is included with insecticides.

Nematicides (Fumigant Types)

Nine percent of the planted acres were treated with a nematicide (Table 3). Just over 50,000 acre-treatments were made with almost 5.3 million pounds (a.i.) applied an average rate of 99 pounds (a.i.) per acre ranging from 55 to 165.

In general, nematode problems were reported in all regions where fall potatoes were produced. However, the quantities used and acres treated were so small in the North Central and Northeast region that these estimates were included in the "other" category in Table 8.

Nematodes are a minor problem when compared to other pests. However, localized problems such as the root knot nematode in the Western region and the golden nematode on Long Island have been difficult to control. Nematodes are more of a problem where the growing season is long. Nematicides were not reported used in Colorado, North Dakota, Maine, and Pennsylvania.

Three nematicides made up 94 percent of the total quantity applied:

chloropicrin plus dichloropropene (C/D), dichloropropene-dichloropropane (D/D), and dichloropropene (D). These soil fumigants are applied preplant to control nematodes. However, other pests such as certain weeds, soil insects and fungi are also controlled (8).

Vine killers

In the 11 States surveyed, 46 percent of the planted acres were treated with a vine killer in preparation for harvesting potatoes. Vine killing prevents further growth of the tuber and permits the skin to "set", reducing damage in harvesting and storing. Growers treated 80 percent of their potato acreage in the Northeast, 55 percent in the North Central, and 29 percent in the Western region with vine killers (Table 3).

Nationwide, vine killers were used in 560,000 acre-treatments, applying 1.2 million pounds (a.i.), at an average rate of 2.1 pounds (a.i.) per acre (Table 4). Chemicals are not commonly used where natural factors such as frost and dry weather kill the vines. Proportionately more acre-treatments are made in the Northeast and the North Central region than in the West. The Northeast growers plant one-fifth of the fall potatoes but account for two-fifths of the vine killer acre-treatments (Table 9). The relationship is the same in the North Central region but not to the same degree. In the Western region the relationship is reversed. The West plants 50 percent of the fall potatoes but makes just over 25 percent of all vine killing treatments.

Dinoseb dominates the chemicals used as vine killers in each of the producing regions. It was used in 93 percent of all vine killing acre-treatments. Endothall was second in acre-treatments accounting for 2 percent of the total. Dinoseb is used as a vine killer as well as an herbicide. The weed control use was 10 percent of the total acre-treatments and the vine killer use was 90 percent.

Table 8. Nematicide use on fall potatoes in the United States, 1979 a/

Region and nematicide	Treated acres b/	Acre-treatments	Quantity applied (a.i.) Total	Per acre Treated	Per acre Treatment	Times applied
	1,000	1,000	1,000 lbs.	Lbs.	Lbs.	No.
Western						
C/EDB c/	2.0	2.0	109.3	54.7	54.7	1.0
C/D d/	10.8	10.8	1,585.2	146.8	146.8	1.0
D/D e/	10.9	10.9	1,802.0	165.3	165.3	1.0
D f/	13.0	13.0	1,637.7	126.0	126.0	1.0
Other g/	-	1.2	119.3	-	99.4	-
Total	-	37.9	5,253.5	-	138.6	-
North Central h/						
Northeast h/						
3 Regions						
C/EDB c/	2.0	2.0	109.3	54.7	54.7	1.0
C/D d/	10.8	10.8	1,585.2	146.8	146.8	1.0
D/D e/	10.9	10.9	1,802.0	165.3	165.3	1.0
D f/	13.0	13.0	1,637.7	126.0	126.0	1.0
Other g/	-	17.4	208.5	-	12.0	-
Total	-	54.1	5,342.7	-	98.8	-

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materals may have been used on the same acre resulting in multiple counting.

c/ Chloropicrin + ethylene dibromide.

d/ Chloropicrin + dichloropropene.

e/ Dichloropropene - dichloropropane.

f/ Dichloropropene.

g/ Includes materials not reported at regional level due to a limited number of observations.

h/ Data not reported because of a limited number of observations.

Generally, a vine killer is applied once about 2 weeks before harvest. However, in the Northeast, because of strong vine growth more than one spraying is usually necessary. The 1979 survey indicated spraying to kill vines occurred from 1.0 to 1.4 times in the Northeast (Table 9). The Western region made on the average 1.0 application per season. Application rates per acre-treatment in the 11 States surveyed averaged 2.1 pounds (a.i.), with a high of 2.8 pounds in the Northeast and a low of 1.6 in the West.

Growth regulators

About 5 percent of the fall potato acreage was field treated with the growth regulator maleic hydrozide which prevents sprouting during storage (Table 3). The relatively small amount used was due to the availability of other growth regulators such as chlorproham (CIPC), which is applied as an aerosol in potato storage and tecnazene (TCNB), a weak growth inhibitor used to retard growth of stored seed potatoes. Growth regulators are used when the storage period is expected to be longer than the potato's rest period. Potatoes expected to be in storage from January to July are generally treated (10). Potatoes marketed after harvest in October and through December are not as likely to be treated.

Growers made about 54,000 acre-treatments using 166,000 pounds (a.i.), less than 1 percent of the quantity of all pesticides (Table 4). The use of growth regulators is dependent upon a number of factors not associated with potato production. Some of these factors are the length of time fresh potatoes are to be stored, type of processing (chip, fry, or other) and available facilities for using chlorpropham. For these reasons, acre-treatments and quantities applied have little relationship to the distribution of planted acres by region.

About 55 percent of all acre-treatments of growth regulators were made in

Table 9. Vine killer use on fall potatoes in the United States, 1979 a/

Region and vine killer	Treated acres b/	Acre-treatments	Quantity applied (a.i.) Total	Per acre Treated	Per acre Treatment	Times applied
	1,000	1,000	1,000 lbs.	Lbs.	Lbs.	No.
Western						
Dinoseb	140.3	142.8	223.5	1.6	1.6	1.0
Other	-	12.0	28.9	-	2.4	-
Total	-	154.8	252.4	-	1.6	-
North Central						
Dinoseb	151.1	184.3	334.5	2.2	1.8	1.2
Other	-	2.6	2.0	-	.8	-
Total	-	186.9	336.5	-	-	-
Northeast						
Ametryn	5.0	5.4	12.4	2.5	2.4	1.1
Dinoseb	131.4	189.7	531.2	4.0	2.8	1.4
Endothall	9.5	11.4	8.9	.9	.8	1.2
Paraquat	7.6	7.9	6.1	.8	.8	1.0
Other	-	.6	2.2	-	3.7	-
Total	-	215.0	560.8	-	2.6	-
3 Regions						
Ametryn	5.0	5.4	12.4	2.5	2.3	1.1
Dinoseb	422.8	516.8	1,089.2	2.6	2.1	1.2
Endothall	9.5	11.4	8.9	.9	.8	1.2
Paraquat	7.6	7.9	6.1	.8	.8	1.0
Other	-	15.2	33.1	-	2.2	-
Total	-	556.7	1,149.7	-	2.1	-

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materals may have been used on the same acre resulting in multiple counting.

the North Central region and 15 percent in the Northeast (Table 10). The application rate was about 3.0 pounds per acre-treatment in all regions.

Another material used as a growth regulator is 2,4-D. It is used to enhance the color of red potatoes and is used to a very limited extent in North Dakota. Only a very small amount was reported used for this purpose and therefore was included in the "other" category.

Tank-mixes

Applications of pesticides as tank-mix combinations is not a widely practiced technique in fall potato production. In 1979, pesticides applied as tank-mixes on potatoes were 6 percent of all acre-treatments and 6 percent of the total quantity (Table 4). Table 11 presents 37 different tank-mixes selected for presentation. They represent 64 percent tank-mix acre-treatments. Of the 37 tank-mixes selected for presentation, 24 of them included a fungicide and 15 of them included maneb/mancozeb.

Table 10. Growth regulator use on fall potatoes in the United States, 1979 a/

Region and growth regulator	Treated acres b/	Acre-treatments	Quantity applied (a.i.)			Times applied
			Total	Per acre		
				Treated	Treatment	
	1,000	1,000	1,000 lbs.	Lbs.	Lbs.	No.
Western						
Maleic hydrazide c/	16.8	16.8	54.1	3.2	3.2	1.0
North Central						
Maleic hydrazide	28.8	28.8	87.9	3.1	3.1	1.0
Other	-	.6	.1	-	.2	-
Total	-	29.4	88.0	-	3.0	-
Northeast						
Maleic hydrazide	7.7	7.7	23.4	3.0	3.0	1.0
3 Regions						
Maleic hydrazide	53.3	53.3	165.4	3.1	3.1	1.0
Other	-	.6	.1	-	.2	-
Total	-	53.9	165.5	-	3.1	-

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materals may have been used on the same acre resulting in multiple counting.

c/ Includes materials not reported at regional level due to a limited number of observations.

Table 11. Summary of tank-mixes used on fall potatoes in the United States, 1979 a/

Tank-mixes	Treated acres b/	Acre-treatments	Total quantity lbs. a.i.	Times applied	State using
	------	1,000	------	No.	
Alachlor + linuron	7.5	7.6	12.3 5.3	1.0	PA, MI, WI
Alachlor + metribuzin	2.3	2.3	4.2 1.1	1.0	MI, WI
Azinphosmethyl + captafol	1.0	2.9	1.4 2.5	2.9	MN
Azinphosmethyl + maneb/mancozeb	11.8	25.6	9.3 33.9	2.2	ME, MI, MN NY, ND, WI
Captafol + endosulfan	1.0	1.0	.8 1.2	1.0	MN
Captafol + methamidophos	1.8	3.0	4.1 2.4	1.7	WA
Captafol + methamidophos + sulfur	1.2	1.2	1.3 1.2 3.4	1.0	WA
Captafol + sulfur	2.4	6.5	8.8 23.9	2.7	WA
Carbaryl + dimethoate	1.9	7.4	8.2 3.7	3.9	ND
Carbaryl + maneb/mancozeb	7.6	16.9	16.2 21.2	2.2	ME, MI, MN, PA
Chlorothalonil + demeton	.9	.9	.8 2.8	1.0	ME
Chlorothalonil + dinoseb	1.6	1.6	1.2 6.0	1.0	ME, PA
Chlorothalonil + methoamidophos	1.9	3.3	2.3 2.4	1.7	MI, WI
Chlorothalonil + parathion	1.2	3.3	2.9 1.7	2.8	MI

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Table 11. Summary of tank-mixes used on fall potatoes in the United States, 1979 a/ -- continued

Tank-mixes	Treated acres b/	Acre-treatments	Total quantity lbs. a.i.	Times applied	State using
	------	1,000	------	No.	
Copper + maneb/mancozeb	2.1	4.5	3.7 4.1	2.1	MI
Demeton + maneb/mancozeb	17.2	24.2	9.0 29.6	1.4	ME
Demeton + metiram	4.4	8.8	2.1 11.8	2.0	ME
Dimethoate + fentin hydroxide	2.4	7.2	2.1 1.3	3.0	MN
Dimethoate + maneb/mancozeb	1.3	2.2	.7 3.0	1.7	MI, MN
Dinoseb + maneb/mancozeb	11.5	14.4	38.6 20.2	1.3	ME, NY, PA
Endosulfan + maneb/mancozeb	3.6	8.3	4.6 7.0	2.3	ME, MI, MN, NY
Endosulfan + parathion	1.8	2.3	1.7 1.1	1.3	MI
EPTC + trifluralin	2.4	2.4	3.3 1.4	1.0	OR
Fentin hydroxide + phosphamidon	3.8	11.4	1.4 5.0	3.0	ND
Maneb/mancozeb + methamidophos	17.0	29.8	40.6 22.7	1.8	ME, MI, NY, PA, WA, WI
Maneb/mancozeb + methamidophos + sulfur	1.8	4.2	6.7 3.0 19.0	2.3	WA
Maneb/mancozeb + metiram	1.3	1.3	1.0 1.5	1.0	ND
Maneb/mancozeb + maleic hydrazide	3.1	3.1	8.0 11.0	1.0	PA

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Table 11. Summary of tank-mixes used on fall potatoes in the United States, 1979 a/ -- continued

Tank-mixes	Treated acres b/	Acre-treatments	Total quantity lbs. a.i.	Times applied	State using
	1,000			No.	
Maneb/mancozeb + parathion	4.0	7.1	9.5	1.8	ME, NY
Maneb/mancozeb + permethrin	3.4	5.8	8.8 .8	1.7	PA
Maneb/mancozeb + phosmet	1.7	4.3	6.0 2.0	2.5	NY, PA
Maneb/mancozeb + phosphamidon	1.9	3.9	4.8 1.9	2.1	MN
Metallic copper + zinc sulfate	8.4	8.4	11.4 11.4	1.0	CO
Methamidophos + metiram	3.3	6.7	4.2 8.5	2.0	MI, WA
Methamidophos + metiram + sulfur	1.2	2.4	2.4 3.8 6.6	2.0	WA
Methyl parathion + parathion	8.2	10.8	4.8 9.6	1.3	OR
Metiram + sulfur	2.4	2.4	4.3 5.5	1.0	WA
Other	-	143.9	348.8	-	
Total	-	403.3	909.6	-	

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division.

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Appendix Table 1. Coefficients of variation for acres of potatoes treated with pesticides in the United States, 1979 a/

Pesticides	Western	North Central	Northeast	United States
	Percent			
Herbicides				
Alachlor	39	17	-	15
Chlorobromuron	-	50	42	32
Dalapon	-	30	27	20
Diphenamid	37	b/	-	34
EPTC	10	11	11	7
Linuron	-	11	9	7
Metribuzin	4	7	7	3
Trifluralin	10	-	-	10
Fungicides				
Anilazine	41	-	-	41
Captafol	13	24	15	9
Chlorothalonil	13	11	12	8
Copper	b/	11	39	11
Fentin hydroxide	20	9	b/	8
Maneb/mancozeb	8	5	5	3
Metiram	30	19	19	13
Sulfur	10	-	-	10
Insecticides				
Aldicarb	5	7	6	3
Azinphosmethyl	23	8	19	7
Carbaryl	-	10	17	8
Carbofuran	-	24	8	8
Demeton	-	-	15	15
Dimethoate	-	20	-	20
Disulfoton	7	13	10	5
Endosulfan	12	14	9	7
Fenvalerate	-	-	13	13
Fonofos	7	-	-	7
Malathion	24	-	-	24
Methamidophos	5	7	11	4
Methomyl	b/	22	b/	21
Monocrotophos	b/	17	-	16
Parathion	35	14	13	9
Permethrin	-	-	16	16
Phorate	9	8	27	6
Phosphamidon	b/	17	-	18
Nematicides				
C/EDB c/	51	-	-	51
C/D d/	22	-	-	22
D/D e/	22	-	-	22
D f/	17	-	-	17

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Appendix Table 1. Coefficients of variation for acres of potatoes treated with pesticides in the United States, 1979 a/ -- continued

Pesticides	Western	North Central	Northeast	United States
	Percent			
Vine killers				
Ametryn	-	-	25	25
Dinoseb	7	3	3	3
Endothall	-	b/	24	22
Paraquat	b/	b/	18	18
Growth regulators				
Maleic hydrazide	18	13	24	9

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division. The coefficient of variation is the standard error of the estimate divided by acres treated times 100. The coefficient indicates the relative variation of the estimate. The higher the coefficient, the less reliable the estimate.
b/ Use of this material at the regional level was insignificant.
c/ Chloropicrin + ethylene dibromide.
d/ Chloropicrin + dichloropropene.
e/ Dichloropropene - dichloropropane.
f/ Dichloropropene.
g/ Includes materials not reported at regional level due to a limited number of observations.
h/ Data not reported because of a limited number of observations.

Appendix Table 2. Coefficients of variation for acres of potatoes treated with tank-mixes in the United States, 1979 a/

Tank-mixes	Western	North Central	Northeast	United States
	Percent			
Alachlor + linuron	-	23	b/	22
Alachlor + metribuzin	-	42	b/	39
Azinphosmethyl + captafol	b/	70	-	58
Azinphosmethyl + maneb/mancozeb	-	33	29	22
Captafol + endosulfan	-	70	b/	59
Captafol + methamidophos	57	-	-	57
Captafol + methamidophos + sulfur	70	-	-	70
Captafol + sulfur	50	-	-	50
Carbaryl + dimethoate	-	57	-	57
Carbaryl + maneb/mancozeb	-	30	39	25
Chlorothalonil + demeton	-	-	71	71
Chlorothalonil + dinoseb	-	-	53	53
Chlorothalonil + methamidophos	-	41	-	41
Chlorothalonil + parathion	-	49	b/	47

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Appendix Table 2. Coefficients of variation for acres of potatoes treated with tank-mixes in the United States, 1979 a/ -- continued

Tank-mixes	Western	North Central	Northeast	United States
	Percent			
Copper + maneb/mancozeb	-	38	-	38
Demeton + maneb/mancozeb	-	-	18	18
Demeton + metiram	-	-	37	37
Dimethoate + fentin hydroxide	-	44	-	44
Dimethoate + maneb/mancozeb	-	59	b/	51
Dinoseb + maneb/mancozeb	-	b/	21	21
Endosulfan + maneb/mancozeb	b/	59	46	36
Endosulfan + parathion	b/	40	-	45
EPTC + trifluralin	38	-	-	38
Fentin hydroxide + phosphamadon	-	40	-	40
Maneb/mancozeb + methamidophos	33	30	25	17
Maneb/mancozeb + methamidophos + sulfur	57	-	-	57
Maneb/mancozeb + metiram	-	71	-	71
Maneb/mancozeb + maleic hydrazide	-	b/	34	32

-- continued

Appendix Table 2. Coefficients of variation for acres of potatoes treated with tank-mixes in the United States, 1979 a/ -- continued

Tank-mixes	Western	North Central	Northeast	United States
	Percent			
Maneb/mancozeb + parathion	-	b/	36	33
Maneb/mancozeb + permethrin	-	-	29	29
Maneb/mancozeb + phosmet	-	-	42	42
Maneb/mancozeb + phosphamadon	-	49	-	49
Metallic copper + zinc sulfate	32	-	-	32
Methamidophos + metiram	70	37	-	35
Methamidophos + metiram + sulfur	70	-	-	70
Methyl parathion + parathion	23	b/	b/	21
Metiram + sulfur	50	-	-	50

a/ "1979 Fall Potato Pesticide Survey," USDA, ESCS, Natural Resource Economics Division. The coefficient of variation is the standard error of the estimate divided by acres treated times 100. The coefficient indicates the relative variation of the estimate. The higher the coefficient, the less reliable the estimate.
b/ Use of this material at the regional level was insignificant.